STUDIES ON THE AUSTRALIAN CICINDELIDAE VI: A REVIEW OF THE SUBGENUS *RIVACINDELA* OF THE GENUS *CICINDELA* (COLEOPTERA)[1]

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ABSTRACT: The subgenus *Rivacindela* of the genus *Cicindela* is reviewed and all known species are illustrated. A key is provided for members of the subgenus. The subgenus is redefined and six new species are described: *Cicindela salicursoria* n. sp., *C. cardinalba* n. sp., *C. ozellae* n. sp., *C. velox* n. sp., *C. collita* n. sp. and *C. vannideki* n. sp.

The genus *Rivacindela* was erected by van Nidek (1973) to contain the species *Cicindela blackburni* Sloane and *C. igneicollis* Bates. In the same paper, he speculated that *C. saetigera* W. Horn and *C. browni* Sloane both belonged to the genus, but did not place them due to a lack of material. Freitag (1979), in his review of Australian *Cicindela* (sensu W. Horn), synonomized the name *Rivacindela* and reverted to calling the species complex by the name "*igneicollis* group" as practiced by Sloane (1906) and W. Horn (1926). Sumlin (1981) recalled the name from synonomy and recognized it as a valid subgenus. Freitag's (1979) study was based upon ca. 57 specimens. The current paper, based upon 305 specimens, redescribes all known species and describes six new species. I feel the redescriptions are necessary because two of the taxa (*C. blackburni* and *C. saetigera*) treated by Freitag (1979) were composites encompassing two additional taxa. Much of the data in the current paper was developed during my expeditions to Australia in 1978-1979 and 1985.

MATERIALS AND METHODS

The specimens comprising this study represent the majority of those studied by Freitag (1979) and many that I collected in 1979 and 1985. Material was borrowed from the following institutions and individuals: Australian National Insect Collection, CSIRO, Canberra, A.C.T., Australia (ANIC); British Museum (Natural History), London, England (BMNH); Institut für Pflanzenschutzforschung, D.E.I., Eberswalde-Finow, DDR (DEIC); Museum of Victoria, Melbourne, Vict., Australia (MVC); South Australian Museum, Adelaide, S.A., Australia (SAMC); Entomological Museum, University of Amsterdam, Amsterdam, The Netherlands (UAMC);

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Western Australian Museum, Perth, W.A., Australia (WAMC); Allan Walford-Huggins, Mt. Molloy, QLD., Australia (WHC).

Measurements were made with an American Optical/Spencer dissecting microscope at 10X magnification using an optical micrometer. Body length measurements were taken from the front of the specimen's clypeus to the extreme apex of the elytra. Body width measurements were taken across the apical third of the elytra. Where possible, twelve specimens of each sex were measured, including the largest and smallest specimens; mean figures were then generated from those sums.

Illustrations were made using the microscope above at 10X and 30X magnifications. Drawings were initially pencilled onto tracing paper using the optical micrometer and ratios and then transferred to scratchboard for inking.

Characters utilized to delimit species within this subgenus are used in the key below. Marked variation in any three of these characters (i.e., maculation, pubescence, color) is sufficient to warrant species-level placement.

Subgenus ***Rivacindela*** van Nidek

Type species: *Cicindela blackburni* Sloane (by original designation).

DESCRIPTION: Member of the subfamily Cicindelinae, tribe Cicindelini, subtribe Cicindelina, genus *Cicindela;* eyes large and prominent; elytra usually noticeably wider in apical half than basal half; elytra usually setose at base; majority of species with extensive elytral maculation - a marginal band of white running laterally from the humeral area to the suture and then up the suture; labrum two or three dentate; majority of ventral segments heavily setose; mesosternum glabrous; metasternum glabrous in posterior half; pro- and mesotrochanters each with a single seta; elytral apices faintly microserrate or without microserrations.

REMARKS: Van Nidek (1973) erected *Rivacindela* based upon two series of specimens that he borrowed from the Western Australian Museum (WAM) at Perth, Western Australia (W.A.). He identified one of the species as *C. blackburni* and the other as *C. igneicollis.* Freitag (1979) apparently never saw these specimens as he did not indicate any specimens from the WAM in his study on the *"igneicollis* group" of the genus *Cicindela.* He did note that van Nidek's (1973) generic description of *Rivacindela* fits *C. saetigera* more closely than it does *C. blackburni* as he indicated the type species as *C. blackburni* Sloane (=*C. saetigera* W. Horn) and credited van Nidek with a misidentification in the synonomy of *C. saetigera.* The type species was, indeed, misidentified, but not as indicated by Freitag (1979). During the course of my studies on this group, I was able to borrow the two series that van Nidek originally studied when he described *Rivacindela* plus four specimens sent by van Nidek himself. Both series carry van Nidek determination labels; one series of 22 specimens is labelled *Rivacindela blackburni* Sl. and the other series (3 specimens) is labelled *Rivacindela igneicollis* Bat. Both of the species are

new to science and will be described later in this paper. The problem of the misidentified type species has been referred to the International Commission of Zoological Nomenclature for its opinion.

All known species of the subgenus are inhabitants of salt flats. Their life histories are unknown although I presume they are similar to other saline-dwelling cicindelids such as occur in the Nearctic region. My searches for immatures around the salt flats where I have encountered adults have all yielded negative results. It is possible that the immatures are temporally segregated from the adults to avoid competition; hopefully, this will be determined in the future.

Key to species of **Rivacindela**

1. Antennal scape with a single seta 2
1′. Antennal scape with several setae 7
2. Flightless species, hind wings vestigial, deformed or missing; humeri greatly reduced 3
2′. Species with well-developed flight wings and humeri 5
3. Base of elytra very setose ..... *C. salicursoria,* n. sp.
3′. Base of elytra glabrous or with few setae 4
4. Large species, 19 mm in length; apical lunule not ascending up suture ..... *C. gairdneri* Freitag
4′. Slightly smaller species, 13-14 mm in length; apical lunule ascending partially up suture ..... *C. velox,* n. sp.
5. Maculation running from shoulder to apex 6
5′. Maculation absent from basal half of elytra ..... *C. ozellae,* n. sp.
6. Maculation broad; elytra punctate, shiny; base of elytra with few setae; pronotum without setae along posterior margin ..... *C. cardinalba,* n. sp.
6′. Maculation narrower; elytra granulate-punctate, dull; base of elytra with many setae; pronotum with setae along posterior margin ..... *C. blackburni* Sloane
7. Species with well-developed flight wings and humeri 8
7′. Flightless species, hind wings vestigial; humeri greatly reduced ... *C. vannideki,* n. sp.
8. Frons setose 9
8′. Frons glabrous ..... *C. browni* Sloane
9. Abdominal sternite 6 of female glabrous; female without apical elytral spines; maculation complex (see fig. 10) ..... *C. igneicollis* Bates
9′. Abdominal sternite 6 of female setose; female with apical elytral spines; maculation usually less complex (see fig. 8) 10
10. Elytral color primarily cupreous-red; posterior margin of pronotum without setae ..... *C. saetigera* W. Horn
10′. Elytral color primarily green; posterior margin of pronotum with setae .... *C. collita* n. sp.

Cicindela (Rivacindela) blackburni Sloane
(Fig. 1)

Cicindela blackburni Sloane, 1906:342; Horn, 1915:319; 1926:201; 1938:45; Freitag, 1979:59.

DESCRIPTION: **Head:** Labrum white with four primary setae, tridentate, disc glabrous; scape cupreous with green reflections, equipped with a single sub-apical seta, some specimens also have 2-3 small, erect setae at the base; clypeus, genae, frons and vertex glabrous (except for supraorbital sensory setae).

Thorax: Pronotum heavily setose around all margins, some setae found in disc, granulate-rugose in texture, sub-quadrate in shape; all ventral and lateral segments (except meso- and metasterna) with dense covering of white, decumbent setae; mesosternum glabrous; metasternum glabrous in posterior half.

Abdomen: Lateral edges densely covered with white, decumbent setae; female with 6th segment devoid of large, white setae; most of venter of both sexes with very small, erect, clear setae, in addition to the erect, sensory setae.

Elyra: Male, nearly parallel-sided in shape, wider from basal third to apical third then rounded to apex; female, wider than male from basal third to apical third then rounded to apex; both sexes with white, decumbent and erect setae (>40) along basal margin and extending slightly into disc, strong humeri and subsutural rows of small foveae; both sexes without microserrations; male without apical spine, female with apical spine; maculation consists of a band of white running laterally from the shoulder to the apex and then up the suture to near or just beyond the apical third, the lunules, although confluent are quite discernable; texture punctate-granulate.

Color: Head, metallic cupreous with slight green reflections, antennal segments 1-4 metallic cupreous with green reflections; pronotum cupreous with green reflections, median sulcus metallic green; elytra cupreous with green punctae; lateral thoracic segments metallic cupreous with green reflections; ventral segments and abdomen brown-testaceous.

Size: Male, 9.7 mm in length and 3.5 mm in width; range 9.2-10.1 mm in length and 3.2-3.7 mm in width (n=12); female, 10.7 mm in length and 4.4 mm in width; range 10.3-10.9 in length and 4.2-4.6 in width (n=12).

Holotype: Female, W.A.: Norseman. Not seen. MVC, depository.

Co-type: Female. W.A.: Norseman. DEIC, depository.

Type locality: W.A.: Lake Cowan; **here designated.**

Distribution: W.A.: Lake Cowan; Northern Territory (N.T.): Newhaven Station? (Freitag, 1979).

Activity period: Presently known to be active during the early autumn.

Diagnosis: *C. blackburni* may only be confused with one other species - *C. salicursoria* n. sp. It differs from that species by its more prominent shoulders, shorter legs, functional flight wings and elytral pubescence.

REMARKS: *C. blackburni* was described by Sloane (1906) from two female specimens given to him by French. Until I collected a lengthy series (82 specimens) at the type locality in 1985, the species was known only from those two specimens. Although *C. blackburni* was treated by Freitag (1979), the majority of specimens in his study were actually a new species and not *C. blackburni.* The identity of the female specimen from N.T. listed by Freitag (1979) is somewhat in doubt as it cannot be found at the University of Sydney (F.J.D. McDonald, *in litt.*), its reported depository. I have not seen the type as the MVC would not risk the specimen to the mails.

I compared my series to the co-type from the W. Horn Collection and the comparison was quite favorable. Sloane (1906) stated that the type specimens had come from the "Norseman District" while the co-type carries a label stating "Norseman;" the type, according to Freitag (1979) carries the same label. I thoroughly investigated the area around the town of Norseman in 1979 and found no evidence of saline habitats. As the co-type is virtually identical with most females from my Lake Cowan series, I hereby establish Lake Cowan as the correct type locality in accordance with Article 72(h) of the ICZN. I found the species to prefer the margins of Lake Cowan; no specimens were observed further than 100 m from the playa margins. Unlike other species of *Rivacindela, C. blackburni* is fairly quick to take flight, but generally does not fly more than 5 m before alighting. Although not attracted to lights, it is active on the salt flats at night.

Cicindela (Rivacindela) salicursoria, new species
(Fig. 2)

Cicindela blackburni of van Nidek, 1973, not Sloane, 1906.
Cicindela saetigera of Freitag, 1979, not W. Horn, 1893.

DESCRIPTION: **Head:** Labrum white with 4 primary setae, tridentate, disc glabrous; scape cupreous with green reflections, equipped with a single sub-apical seta, several examined specimens also have 2-3 small erect setae at the base; clypeus, gena, frons and vertex glabrous (except for supraorbital sensory setae).

Thorax: Pronotum heavily setose around all margins, some setae found in disc, granulate-rugose in texture, cylindrical in shape; all ventral and lateral segments (except meso- and metasterna) with dense covering of white, decumbent setae; mesosternum glabrous; metasternum glabrous in posterior half.

Abdomen: Lateral edges densely covered with white, decumbent setae, female with segment 6 devoid of large, white setae; majority of venter of both sexes with very small, erect, clear setae.

Elytra: Male, ovoid in shape, wider from basal third to apical third then rounded to apex; female, markedly wider from basal third to apical third then rounded to apex; both sexes with white, decumbent and erect setae from basal margin extending into basal third, very reduced humeri, vestigial flight wings and sub-sutural rows of small foveae; both sexes without microserrations and apical spines; maculation very similar to *C. blackburni* except that the middle band is usually somewhat narrower; texture punctate-granulate.

Color: Head, metallic cupreous with green reflections, antennal segments 1-4 metallic cupreous with green reflections; pronotum cupreous with green reflections, median sulcus metallic green; elytra cupreous with green punctae; lateral thoracic segments metallic cupreous with green reflections; ventral segments and abdomen brown-testaceous.

Size: Male, 9.6 mm in length and 3.9 mm in width; range 9.3-9.8 mm in length and 3.7-4.1 mm in width (n=12); female, 11.2 mm in length and 4.7 mm in width; range 10.8-11.4 in length and 4.5-4.9 in width (n=12).

Holotype: Male. W.A.: Lake Lefroy, 4 km N Widgiemooltha, 5-IV-1985, W.D. Sumlin.

Allotype: Female. Same data as holotype.

Paratypes: 27 ♂♂, 13 ♀♀ same data; 2 ♂♂, 1 ♀ W. Australia, Widgiemooltha, 26-IV-1962, J. and A. Douglas.

Type locality: W.A.: Lake Lefroy.

Distribution of Type Series: Holotype to the Australian National Insect Collection, CSIRO, Canberra, ACT. Three paratypes to the University of Amsterdam, Amsterdam, The Netherlands. One paratype to each of the following institutions and individuals: South Australian Museum, Adelaide, S.A.; Museum of Victoria, Melbourne, Victoria; Queensland Museum, Brisbane, QLD.; Institut für Pflanzenforschung, Eberswalde-Finow, DDR; British Museum (Natural History), London, England; Allan Walford-Huggins, Mt. Molloy, QLD.; Ed V. Gage, San Antonio, Texas; Walter Johnson, Minneapolis, Minnesota. The allotype and remaining paratypes to the Sumlin collection.

Etymology: Name from the Latin *salis* (salt) and *cursor* (a runner).

Activity period: Presently known to be active in the early autumn.

Diagnosis: Very closely related to *C. blackburni.* It differs from *C. blackburni* by having much longer legs, very reduced shoulders, vestigial flight wings, very setose elytra, an almost cylindrical prothorax, oval elytra and no elytral spines.

REMARKS: I found this species to inhabit the margins and salt crusts of Lake Lefroy. The highway approaches to within 150 m of the playa 4 km north of Widgiemooltha and there is a jeep trail leading down to the lake's shore at that point. I found it active around the playa margins and out on the salt crust (ca. 150-200 m out on the flats). The specimens that were taken around the margins of the playa were of a much redder color than those found out on the salt crust and are presumed to be teneral adults. The species was not common at the type locality, but I managed to collect 42 specimens in just over an hour. Although *C. salicursoria* cannot fly, it is extremely fleet of foot and difficult to net. The beetles would usually wait until I was close to them and then break into a very fast zig-zag pattern run, always with the direction of the wind.

Cicindela (Rivacindela) cardinalba, new species
(Fig. 3)

Cicindela blackburni of Freitag, 1979, not Sloane, 1906.

DESCRIPTION: Head: Labrum white with 4 primary setae, tridentate, disc glabrous; scape equipped with a single sub-apical seta; clypeus, gena, frons and vertex glabrous.

Thorax: Pronotum with white decumbent setae along all margins except posterior, a few setae extend into the disc, finely rugose in texture, with rounded sides; all lateral and ventral segments (except meso- and metasterna) clothed in white, decumbent setae; mesosternum glabrous; metasternum glabrous in posterior half.

Abdomen: Lateral edges densely covered with white, decumbent setae; female with segment 6 glabrous; both sexes glabrous medially (except for erect, sensory setae).

Elytra: Male: Nearly parallel-sided although slightly wider from basal third to apical third then rounded to apex; female, markedly wider from basal third to apical third then rounded to apex; both sexes with apical microserrations, setae along basal margin (<10/elytron), strong humeri and subsutural rows of small foveae; male without apical spines, females with apical spines; maculation similar to *C. saetigera,* but slightly more confluent and the apical lunule usually does not ascend up the suture; texture tending more toward punctate, shiny.

Color: Head: majority metallic blue and green with some cupreous reflections, vertex metallic red-cupreous; antennal segments 1-4 metallic cupreous with green reflections; pronotum red-cupreous; elytra bright red-cupreous; lateral segments bright cupreous with green reflections;

ventral segments mostly metallic green with cupreous reflections; abdomen brown-testaceous with metallic green edges.

Size: Male, 9.7 mm in length and 3.4 mm in width; range 9.4-10.3 in length and 3.1-3.6 in width (n=12); female, 11.5 mm in length and 4.3 mm in width; range 11.0-11.7 mm in length and 4.1-4.5 in width (n=12).

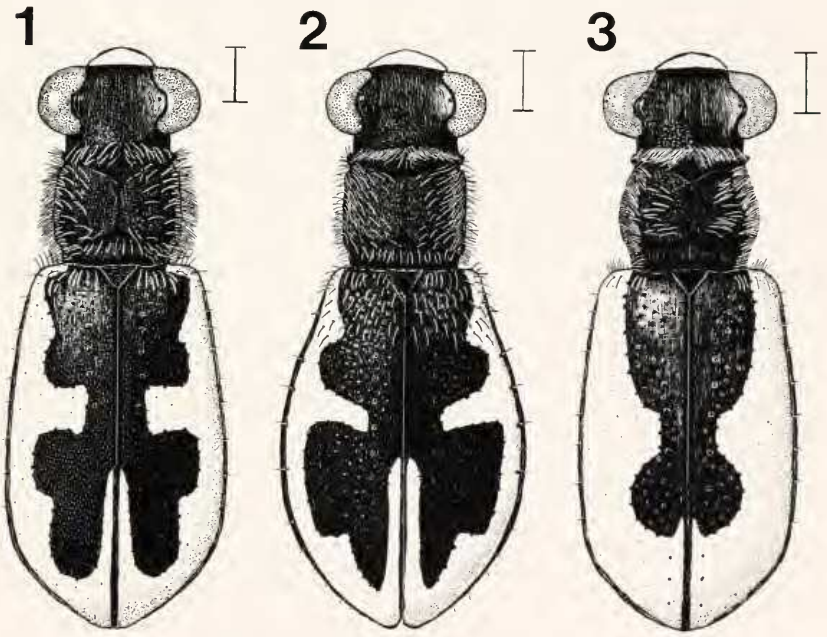
Holotype: Male. S.A.: Old Coward Springs, 10-IV-1985, W.D. Sumlin.

Allotype: Female. Same data as holotype.

Paratypes: 11 ♂♂, 13 ♀♀ same data; 4 ♂♂, 8 ♀♀, S.A.: Lake Eyre South, 10-IV-1985, W.D. Sumlin; 1 ♂, 4 ♀♀, S.A.: Lake Eyre, dead on salt, south shore, 23-IV-1955, G.F. Gross; 1 ♀, S.A.: Lake Eyre, dead on salt surface, Sulphur Pen., 21-VIII-1967, G.F. Gross; 2 ♀♀, S.A.: Lake Eyre, V-1953, K.P. Jones & party; 1 ♂, 4 ♀♀, S.A.: Wobna Mound Spring, +5 mi SE Coward Spring, wet crusty salt surface, day/mating, 30-III-1969, A. Kowanko.

Type locality: S.A.: Old Coward Springs. This is not to be confused with New Coward Springs which is several kilometers to the northeast. Old Coward Springs is approximately 200 m south of the Oodnadatta Track.

Distribution of Type Series: Holotype and 13 paratypes to the South Australian Museum, Adelaide, S.A. Two paratypes to the Australian National Insect Collection, CSIRO, Canberra, ACT. One paratype to each of the following institutions and individuals: National Museum of Victoria, Melbourne, Victoria; Queensland Musuem, Brisbane, QLD.; Institut für Pflanzenforschung, Eberswalde-Finow, DDR; British Museum (Natural History), London, England; Allan Walford-Huggins, Mt. Molloy, QLD.; Ed V. Gage, San Antonio, Texas; Walter



Figs. 1-3. Dorsal habitus of: 1) male *C. blackburni* Sloane, 2) male *C. salicursoria* n.sp., 3) male *C. cardinalba* n. sp. Scale lines indicate 1 mm.

Johnson, Minneapolis, Minnesota. Allotype and remaining paratypes to the Sumlin collection.

Etymology: Name from the Latin *cardinalis* (red) and *alba* (white) alluding to the species' distinctive red and white appearance.

Activity period: Presently known to be active during the early autumn.

Diagnosis: Closely related to *C. blackburni*, but differing in its broader maculation, elytral, pronotal and abdominal pubescence, shape of the prothorax, elytral texture and bright red color.

REMARKS: In addition to morphological characters, the new species differs markedly in its behavior; its flight is quite different from *C. blackburni* in that it lifts higher off the substrate when taking to wing, flies much stronger and flies farther (10-15 m as opposed to 5 m). I found it inhabiting salt crust at both Old Coward Springs and Lake Eyre South where it proved quite skittish and difficult to net. Capturing specimens at Lake Eyre proved to be a major undertaking as I kept breaking through the salt crust and sinking into the black, underlying mud. I felt very fortunate to net 12 specimens at that location.

Cicindela (Rivacindela) ozellae, new species
(Fig. 4)

DESCRIPTION: Head: Labrum white with 4 primary setae, tridentate, disc glabrous; scape equipped with a single, subapical seta; clypeus, gena, frons and vertex glabrous (except for supraorbital sensory setae).

Thorax: Pronotum setose on all margins, lightly rugose in texture; all lateral and ventral segments (except meso- and metasterna) with light to dense covering of white, decumbent setae; meso- and metasternum glabrous.

Abdomen: Lateral edges lightly to densely clothed in white, decumbent setae, glabrous medially (except for sensory setae).

Elytra: Male: nearly parallel-sided though slightly wider from basal third to apical third then rounded to apex; female: unknown; male with setae (<15/elytron) along basal margin, rows of small, subsutural foveae and minute apical microserrations; male without apical spine; maculation consists of band of white beginning in basal half and running laterally to the apex, no ascending basal lunule present; texture punctate, shiny.

Color: Head, metallic green and blue with slight cupreous reflections; antennal segments 1-4 metallic green with cupreous reflections; pronotum cupreous with green reflections, median sulcus metallic green; elytra rose-cupreous with green punctae; lateral segments metallic blue with green reflections; ventral segments mostly green metallic; abdomen brown-testaceous.

Size: Male. 8.5 mm in length and 3.3 mm in width; range same as mean (n=2).

Holotype: Male. S.A.: Eucolo Creek at Island Lagoon, 31.8 km W Woomera, 13-IV-1985, W.D. Sumlin; SAMC, depository.

Paratype: Male. Same data excpet 9-IV-1985; Sumlin collection, depository.

Type locality: S.A.: Island Lagoon.

Distribution: At present, known only from the type locality.

Etymology: I take pleasure in naming this species after my late mother, Ozella R. Sumlin.

Activity period: Known to be active during the early autumn.

Diagnosis: Closest to *C. cardinalba.* May be told from that species by its much smaller size, pronotal pubescence, reduced maculation, rose-red color and elytral texture..

REMARKS: This species was extremely scarce at the type locality; I spent nearly 8 hours walking the flats of Island Lagoon to collect the two specimens comprising the type series. At first glance, the species does not appear to be a member of *Rivacindela,* but a close examination discloses the setose elytra, densely setose undersides and characteristic aedeagus.

Cicindela (Rivacindela) velox, new species
(Fig. 5)

DESCRIPTION: **Head:** Labrum white with 4 primary setae, males bidentate, females tridentate, disc glabrous; scape equipped with a single sub-apical seta; clypeus, gena, frons and vertex glabrous (except for supraorbital, sensory setae).

Thorax: Pronotum with sparse, decumbent and erect setae on lateral and anterior margins, glabrous on posterior margin, a few setae extending into disc, rugose in texture, sides slightly rounded; all lateral and ventral segments (except meso- and metasterna) with light to dense covering of white, decumbent setae; meso- and metasternum glabrous.

Abdomen: Lateral edges lightly to densely clothed in white, decumbent setae; female with segment 6 glabrous; both sexes glabrous medially (except for erect, sensory setae).

Elytra: Oval in shape, widest from basal third to apical third then rounded to apex; both sexes with very small, indistinct subsutural foveae, reduced humeri and several very small setae (<5/elytron) at the base; males, without apical spines, females, with apical spines; both sexes without microserrations; flight wings present, but they are so distorted in shape that they are useless for flight; maculation consists of a single band of white beginning in the basal third and running laterally rearward to the apex and then slightly up the suture to the apical fourth.

Color: Majority of head dark, burgundy-red with cupreous and green reflections; antennal segments 1-4 burgundy-red with some cupreous reflections; pronotum dark burgundy-red with slight, green reflections; lateral segments burgundy-red with extensive light cupreous and green reflections; ventral segments largely cupreous and green metallic; abdomen brown-testaceous with lateral edges cupreous and green.

Size: Male, 13.2 mm in length and 5.7 mm in width; range 12.9-13.5 in length and 5.1-5.9 in width (n=6); female, 14.3 mm in length and 6.3 mm in width; range 14.0-14.7 in length and 5.9-6.5 in width (n=6).

Holotype: Male. W.A.: Lake Cowan, 19.1 km N Norseman, 4-IV-1985, W.D. Sumlin.

Allotype: Female. Same data.

Paratypes: 8 ♂♂, same data; 6 ♀♀ same data.

Type locality: W.A.: Lake Cowan.

Distribution: Known only from the type locality.

Distribution of Type Series: Holotype to the Australian National Insect Collection, CSIRO, Canberra, ACT. One paratype to each of the following institutions and individuals: South Australian Museum, Adelaide, S.A; Queensland Museum, Brisbane, QLD.; Institut für Pflanzenforschung, Eberswald-Finow, DDR; Allan Walford-Huggins, Mt. Molloy, QLD.; Ed V. Gage, San Antonio, Texas; Walter Johnson, Minneapolis, Minnesota. The allotype and remaining paratypes to the Sumlin collection.

Etymology: From the Latin for swift, alluding to the species' rapid running ability.

Activity period: Active in early autumn.

Diagnosis: *C. velox* can only be confused with *C. gairdneri;* it differs from that species by its smaller size, maculation and pronotal pubescence.

REMARKS: I found this species far out on the salt flats of Lake Cowan. The species would, in all cases, wait until I was nearly on top of it before it moved; when it moved, it always broke into an exceedingly fast

run, and always in a straight line with the direction of the wind. The beetles were so fast that I had to break into an immediate run in order to intercept them. On two occasions, large females actually outran me for distances of 10-15 m! The species was not common at the type locality during my stay as I saw and collected only about two an hour.

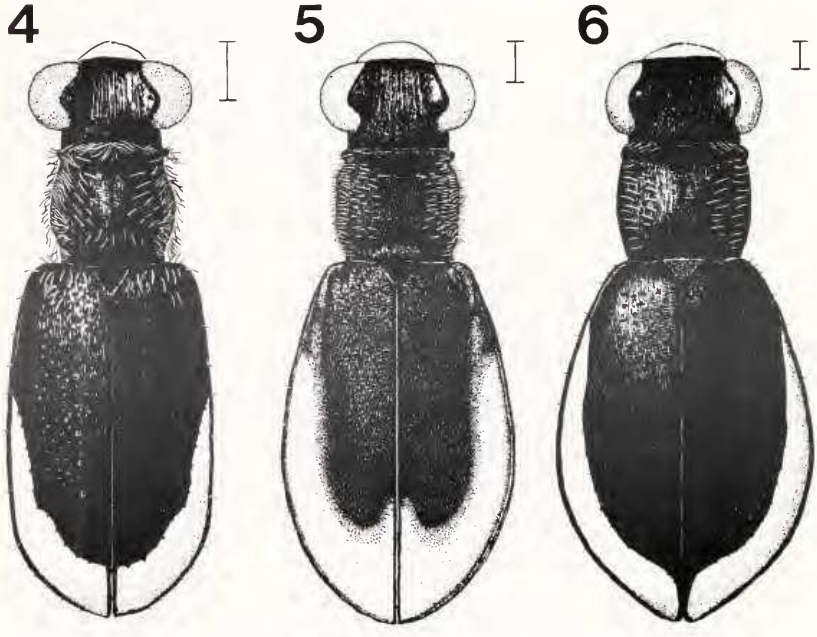
Cicindela (Rivacindela) gairdneri Freitag
(Fig. 6)

Cicindela gairdneri Freitag, 1979:63.

DESCRIPTION: **Head:** Labrum white with 4 primary setae, female tridentate, male unknown, disc glabrous; scape equipped with a single sub-apical seta; clypeus, gena, frons and vertex glabrous (except for supraorbital, sensory setae).

Thorax: Pronotum with sparse, decumbent and erect setae on lateral margins, glabrous on posterior margin and medial area of anterior margin, disc glabrous, slightly rugose in texture, sides nearly parallel-sided; all lateral and ventral segments (except meso- and metasterna) with light to dense covering of white, decumbent setae; meso- and metasterna glabrous.

Abdomen: Lateral edges lightly to densely clothed in white, decumbent setae; female with segment 6 glabrous, glabrous medially (except for erect, sensory setae).



Figs. 4-6. Dorsal habitus of: 4) male *C. ozellae* n.sp., 5) male *C. velox* n.sp., 6) holotype female *C. gairdneri* Freitag. Scale lines indicate 1 mm.

Elytra: Female markedly oval in shape, widest from basal third to apical third then rounded to apex; male unknown; female with very small, indistinct subsutural foveae, very reduced humeri and apical spines; base of elytra without setae; apex without microserrations; flight wings absent; maculation consists of a band of white beginning in the basal fourth and running laterally posteriorad to the apex.

Color: Most of head dark, burgundy-red with cupreous and green reflections; antennal segments 1-4 burgundy-red with slight cupreous reflections; pronotum dark burgundy-red with slight, green reflections; lateral segments burgundy-red with extensive light cupreous and green reflections; ventral segments largely cupreous and green metallic; abdomen brown-testaceous with cupreous and green edges.

Size: Female, 19.1 mm in length and 8.2 mm in width (n=1).

Holotype: Female. SW Gulf L. Gairdner, 18-III-1950. South Australian Museum, Adelaide, S.A., depository.

Type locality: S.A.: Lake Gairdner.

Distribution: Known only from the type locality.

Activity period: The only known specimen was collected during the late summer.

Diagnosis: Easily separated from the other species of *Rivacindela* by its massive size, type of maculation and lack of flight wings.

REMARKS: This species is known only from the holotype specimen. I attempted to collect the species during my expedition in 1985, but getting to the type locality required four-wheel drive - something my rental vehicle did not have. Judging from the holotype's very long legs and massive body, the species may be fleeter of foot than *C. velox*.

Cicindela (Rivacindela) browni Sloane
(Fig. 7)

Cicindela browni Sloane, 1913:401; Horn, 1915:319; 1926:201; 1938:45; Freitag, 1979:61.

DESCRIPTION: **Head:** Labrum white with 4 primary setae, tridentate, disc glabrous; scape metallic cupreous, heavily covered with white decumbent setae; gena lightly setose; clypeus, frons and vertex glabrous; a small tuft of setae found between the antennal socket and the eye.

Thorax: Pronotum setose on all margins, some setae in disc, lightly rugose in texture; all ventral and lateral segments (except meso- and metasterna) with dense covering of white, decumbent setae; mesosternum glabrous; metasternum glabrous in posterior half.

Abdomen: Lateral edges densely covered with white, decumbent setae; segment 6 of female glabrous (except for 2-4 setae on anterior margin; glabrous medially (except for erect sensory) setae).

Elytra: Male: slightly parallel-sided although wider from basal third to apical third then rounded to apex; female, wider from basal third to apical third then rounded to apex; both sexes with a few (<10) white setae along the basal margin, strong humeri and subsutural rows of small foveae; male without microserrations; female with small microserrations at apex; male without apical spines; female with small apical spines; maculation consists of a confluent band starting at the shoulder and then running laterally to the apex, broadening as it goes, and then up the suture to a point in the basal third; texture granulate-punctate.

Color: Head, metallic cupreous with slight green reflections, antennal segments 1-4 metallic cupreous; pronotum cupreous; elytra light cupreous with green punctae; lateral thoracic segments metallic cupreous with slight green reflections; ventral segments and abdomen largely brown-testaceous.

Size: Male, 11.2 mm in length and 4.1 mm in width; range 11.2-11.3 in length and 4.1-4.2 in

width (n=2); female, 12.8 mm in length and 4.8 mm in width; range 12.6-12.9 in length and 4.7-4.9 in width (n=3).

Holotype: Presumed lost.

Co-type: Female. W.A.: Lake Austin, H.W. Brown. MVC, depository.

Co-type: Female. W.A.: Lake Austin, H.W. Brown. DEIC, depository.

Type locality: W.A.: Lake Austin.

Distribution: W.A.: Lake Austin.

Activity period: From all available data, *C. browni* is an autumn species.

Diagnosis: Differs from the other species with setose scapes by its glabrous frons and vertex.

REMARKS: This species is one of the rarest in collections. This is probably due to its remote type locality and activity period. I found it around the margins of Lake Austin on 29 March, 1985. Its behavior was similar to *C. saetigera* in that it flew for long distances (15 m) and was a fast runner.

Cicindela (Rivacindela) saetigera W. Horn
(Fig. 8)

Cicindela saetigera W. Horn, 1893:198; 1915:319; 1926:201; 1938:45; Sloane, 1906:343; Freitag, 1979:58; Sumlin, 1981:279; 1984:197.

Cicindela jungi Blackburn, 1901:15; Rainbow, 1904:245; Sloane, 1906:343; Horn, 1915:319; 1926:201.

DESCRIPTION: **Head:** Labrum white with 4 primary setae, tridentate (strongly so in female), disc lightly to densely clothed in white, decumbent setae; scape cupreous with green reflections, heavily covered with white, decumbent seate; clypeus, gena, frons and anterior portion of vertex covered with white, decumbent setae.

Thorax: Pronotum heavily setose on lateral and anterior margins, granulate-rugose in texture; all ventral and lateral segments (except meso- and metasterna) with dense covering of white, decumbent setae; mesosternum glabrous; metasternum glabrous in posterior half.

Abdomen: Lateral edges densely clothed in white, decumbent setae; female with setae on segment 6, glabrous medially (except for erect sensory setae).

Elytra: Male: sub-ovoid in shape, wider from basal third to apical third then rounded to apex; female, markedly wider from basal third to apical third then rounded to apex; both sexes with white, decumbent and erect setae on basal margins, small humeral angles and sub-sutural rows of small foveae; both sexes without microserrations; male without apical spines, females with apical spines; maculation consists of a confluent band of white running from the shoulder laterally to the apex and then up the suture to a point just below the bulge of the middle lunule; texture granulate-punctate.

Color: Head, metallic green with cupreous reflections, antennal segments 1-4 metallic cupreous; pronotum metallic cupreous with green reflections, median sulcus metallic green; elytra cupreous with green punctae; lateral thoracic segments metallic green with cupreous reflections; ventral segments and abdomen brown-testaceous.

Size: Male, 11.2 mm in length and 4.3 mm in width; range 10.8-11.9 mm in length and 3.9-4.7 in width (n=12); female, 12.4 mm in length and 4.8 mm in width; 11.8-12.8 in length and 4.4-5.1 mm in width (n=12).

Holotype: Female. "Cap York;" DEIC, depository.

Type locality: S.A.: Yorke Peninsula.

Distribution: S.A.: Wallaroo, Lake Crosby, Lake Bumbinga, Tailem Bend, 19.4 km S. Tailem Bend; Vict.: Swan Hill.

Activity period: Active during the summer months.

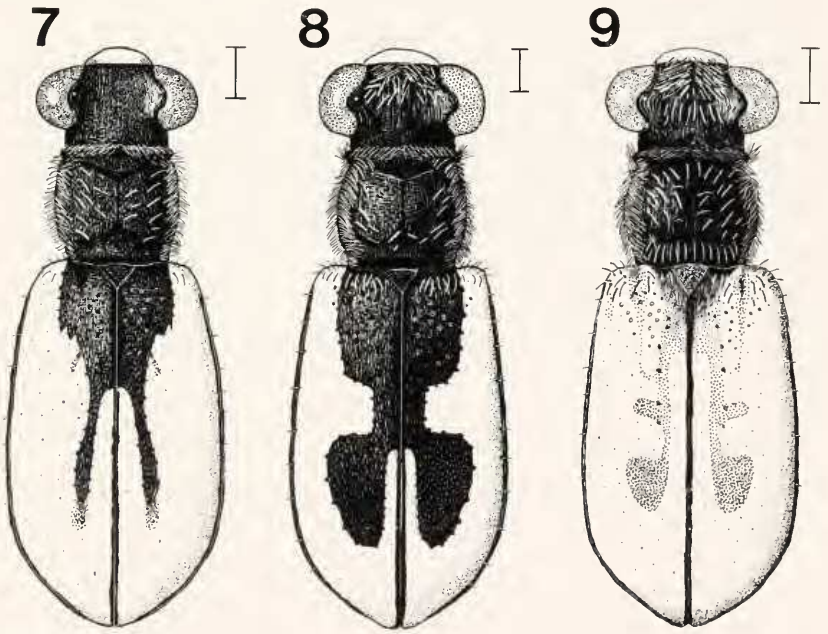
Diagnosis: Closely related to *C. collita* n. sp.; easily separated by its less diffuse maculation, lack of setae along posterior margin of pronotum, red color and larger size.

REMARKS: Contrary to Freitag (1979), I find no tendency toward variation of the elytral maculations in any of the population samples studied; all are essentially identical with the specimen depicted in Fig. 8. This is the most common species of the subgenus but it is not found in many collections. I found it to be a very fast runner and able flier (Sumlin, 1984) on a salt flat in southern S.A. The species is no longer found at Wallaroo due to the destruction of salt flats at that location.

Cicindela (Rivacindela) collita, new species
(Fig. 9)

Cicindela saetigera of Freitag, 1979, not W. Horn, 1893.

DESCRIPTION: **Head:** Labrum white with 4 primary setae, tridentate, disc lightly to densely clothed in white, decumbent setae; scape heavily covered with white, decumbent setae; clypeus, gena, frons and anterior portion of vertex covered with white, decumbent setae.



Figs. 7-9. Dorsal habitus of: 7) male *C. browni* Sloane, 8) male *C. saetigera* W. Horn, 9) male *C. collita* n.sp. Scale lines indicate 1 mm.

Thorax: Pronotum heavily setose on all margins, granulate-rugose in texture; all ventral and lateral segments (except meso- and metasterna) with dense covering of white, decumbent setae; mesosternum glabrous; metasternum glabrous in posterior half.

Abdomen: Lateral edges densely clothed in white, decumbent setae; female with setae on segment 6, glabrous medially (except for erect, sensory setae).

Elytra: Male: sub-ovoid in shape, wider from basal third to apical third then rounded to apex; female, markedly wider from basal third to apical third then rounded to apex; both sexes with white, decumbent and erect setae on basal margins, small humeral angles and subsutural rows of small foveae; both sexes usually without microserrations (some females have minute teeth along apex); male without apical spines, females with apical spines; maculation similar to *C. saetigera,* but much more diffuse and all specimens studied have a basal dot; apical lunule in many specimens ascends up suture to become a basal dot and there is an extension of the basal lunule into the disc; texture granulate-punctate.

Color: Head, metallic green with slight cupreous reflections, antennal segments 1-4 metallic green with cupreous reflections; pronotum dark metallic green with cupreous reflections; elytra dark green with cupreous punctae; lateral thoracic segments metallic green with cupreous reflections; ventral segments and abdomen brown-testaceous.

Size: Male, 10.1 mm in length and 3.8 mm in width; range 9.8-10.2 mm in length and 3.4-4.0 in width (n=6); female, 10.4 mm in length and 4.0 mm in width; range 10.0-10.7 mm in length and 3.8-4.2 in width (n=6).

Holotype: Male. On salt edge of Coorong, S.A., I-1967, P. Gniel.

Allotype: Female. Same data.

Paratypes: 5 ♂♂ same data; 22 ♀♀ same data.

Type locality: S.A.: The Coorong.

Distribution: At present, known only from the type locality.

Distribution of Type Series: Holotype, allotype and 23 paratypes to the South Australian Museum (SAM), Adelaide, S.A.; 4 paratypes to the Sumlin collection.

Etymology: Name from the latin *collitus* (smeared) alluding to the new species' smeared, diffuse maculation.

Activity period: Apparently the same as *C. saetigera.*

Diagnosis: May be told from *C. saetigera* by its broad, diffuse maculation, green color, smaller size and setae on the posterior margin of the pronotum.

REMARKS: The new species was discussed by Freitag (1979) as a geographical variant of *C. saetigera.*

Cicindela (Rivacindela) igneicollis, Bates
(Fig. 10)

Cicindela igneicollis Bates, 1874:262, Sloane, 1906:344; 1913:402; Horn, 1915:319; 1926:201; 1938:4&11; Freitag, 1979:56.

DESCRIPTION: **Head:** Labrum white with four primary setae, female tridentate, male unknown, disc glabrous; scape with covering of white, decumbent setae; clypeus, gena, frons and anterior portion of vertex with white, decumbent setae.

Thorax: Pronotum heavily setose on lateral and anterior margins, lightly rugose in texture, subquadrate in shape; all ventral and lateral segments (except meso- and metasterna) with dense covering of white, decumbent setae; mesosternum glabrous; metasternum glabrous in posterior half.

Abdomen: Lateral edges densely covered in white, decumbent setae; female with segment 6 glabrous; glabrous medially (except for erec sensory setae).

Elytra: Female, vaguely-ovoid in shape, widest from basal third to apical third then rounded to apex; male, unknown; base with white setae; humeri prominent; female without apical spines or microserrations; maculation similar to *C. saetigera* except ascending portion of apical lunule ascends well into basal third and there is a discal lunule running parallel to the apical lunule and marginal line.

Color: Head, metallic cupreous with green reflections; antennal segments 1-4 metallic cupreous; pronotum cupreous with green reflections, sulci green metallic; elytra cupreous with green punctae; lateral thoracic segments cupreous with green reflections; ventral segments and abdomen brown-testaceous.

Size: Female, 13.0 mm in length and 4.9 mm in width (n=1).

Holotype: Female. W.A.: Nickol Bay. Presumed lost or destroyed.

Type locality: W.A.: Nickol Bay.

Distribution: W.A.: Nickol Bay; Western Australia [no specific locality], 1922-1923, B.R. Lucas; BMNH, depository.

Activity period: Unknown.

Diagnosis: Differs from the other members of the subgenus by its maculation and pubescence as outlined in the above key and description.

REMARKS: Bates (1874) described the species from two females given to him by DuBoulay. This species shares with *Nickerlea distipsideroides* W. Horn and *C. gairdneri* the distinction of being the rarest Australian cicindelids in collections. As far as I am able to discern, there are no specimens of this species housed in Australian museums. The British Museum (Natural History) possesses the only known example and it is not one of the Bates specimens. The specimen was determined as *C. igneicollis* by Walter Horn in 1926. It fits Bates' (1874) original description, but due to the loss of the types and the fact that the specimen at hand does not bear a Nickol Bay label, I am inclined to view this specimen as a tentative representative of the species. When specimens are finally collected at the type locality, this tentative determination will be confirmed or rejected. I have visited Nickol Bay twice (1979 & 1985) in attempts to collect the species, but it eluded me on both occasions as it was exceedingly hot in both instances. I suspect that the species would be present when the temperature stabilizes around the 30°C mark. According to Bromwyn Hunt of Karratha, W.A. (pers. comm.), this would be sometime in late April or May. The habitat at Nickol Bay has changed very little since the insect was described except that there is now a large salt extraction plant operated by Dampier Salt Ltd. at the southwest corner of the salt flats.

Cicindela (Rivacindela) vannideki, new species
(Fig. 11)

Cicindela igneicollis of van Nidek, 1973; not Bates, 1874.

DESCRIPTION: **Head:** Labrum white with four primary setae, tridentate, disc glabrous; scape cupreous with green reflections, heavily covered with white, decumbent setae; clypeus, gena, frons and anterior portion of vertex with white, decumbent setae.

Thorax: Pronotum heavily setose on lateral and anterior margins, granulate-rugose in

texture; all ventral and lateral segments (except meso- and metasterna) with dense covering of white, decumbent setae; mesosternum glabrous; metasternum glabrous in posterior half.

Abdomen: Lateral edges densely clothed in white, decumbent setae; female with segment 6 setose, glabrous medially (except for erect sensory setae).

Elytra: Male, sub-ovoid in shape, widest from basal third to apical third then rounded to apex; female, markedly wider from basal third to apical third then rounded to apex; both sexes with white, decumbent and erect setae in basal fourth of dorsal surface, small sub-sutural foveae, very reduced humeri and vestigial flight wings; male, with minute microserrations, female, without microserrations; male, without apical spines, female, with apical spines; maculation similar to *C. igneicollis* except that the discal lunule is not attached to the apical lunule and the middle band is much more pitched and discernable.

Color: Head, metallic cupreous with green reflections, antennal segments 1-4 metallic cupreous; pronotum cupreous with green reflections; elytra dark cupreous with green punctae; lateral thoracic segments metallic green with cupreous reflections; ventral segments and abdomen brown-testaceous.

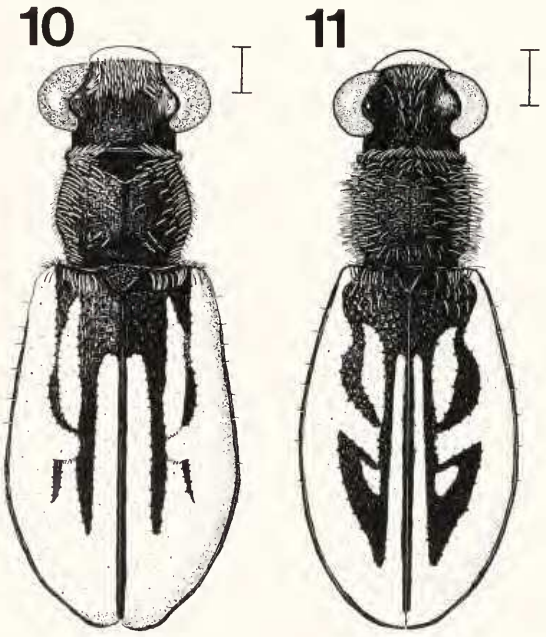
Size: Male, 10.5 mm in length and 3.9 mm in width; range same as means for both length and width (n=2); female, 12.1 mm in length and 4.9 mm in width (n=1).

Holotype: Male. W.A.: North lip of Johnston Lakes, W. of Norseman, 23-III-1968, A. Baynes & J. Bannister; Running on surface of lake; specimen #69-1579; WAMC, depository.

Allotype: Female. Same data (except specimen #69-1581) and depository as holotype.

Paratype: Male. Same data; UAMC, depository.

Type locality: W.A.: Lake Johnston.



Figs. 10-11. Dorsal habitus of: 10) female *C. igneicollis* Bates, 11) holotype male *C. vannideki* n.sp. Scale lines indicate 1 mm.

Etymology: Named in honor of C.M.C. Br. van Nidek, Dutch scholar of the Australian Cicindelidae.

Activity period: From the type specimens, the species is active during the early autumn.

Diagnosis: *C. vannideki* may be separated from the closely related *C. igneicollis* and *C. saetigera* by its maculation, elytral pubescence, reduced shoulders and vestigial flight wings.

REMARKS: This species was apparently the one used by van Nidek (1973) in assessing generic characters for *Rivacindela* as it fits the generic description much better than *"C. blackburni"* with respect to pubescence of the head.

DISCUSSION

From my studies on this subgenus, I believe that the total number of species of *Rivacindela,* when finally described, will far exceed the eleven reviewed in this paper. This projection is based upon the various species' ability to change with the passage of time and the restriction of gene flow from like populations. All of the above species are confined to salt flats and, for the present, are considered to have zero vagility. The number of salt flats in Western Australia, South Australia and Northern Territory that could harbor isolated species is enormous. Most of these flats are in the "outback" and inaccessible to conventional transportation; as more roads are opened and these flats become accessible, the number of known *Rivacindela* species will, in all likelihood, climb accordingly.

As presently defined, there are two main stems of species within *Rivacindela:* the *blackburni* stem (characterized by unisetose scapes and glabrous heads) and the *browni* stem (characterized by multi-setose scapes and setose heads). From out-group comparisons of various character states, I believe the ranking of species presented in this paper to be the most parsimonious. In a future paper (in progress), I will present a phylogeny and male genitalia study for the subgenus.

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